Analysis of 80-MeV Carbon and 80-MeV Nitrogen Ion Irradiation Effects on N-Channel MOSFETs

Arshiya Anjum, T. M. Pradeep, N. H. Vinayakprasanna, N. Pushpa, Ambuj Tripathi, and A. P. Gnana Prakash

Abstract—**N-channel depletion MOSFETs were irradiated with 80 MeV Carbon (C^{6+}) and 80 MeV Nitrogen (N^{6+}) ions in the dose range from 100 krad (Si) to 30 Mrad (Si). The electrical characteristics of MOSFET such as threshold voltage (V_{th}), density of interface trapped charges (ΔN_{it}), density of oxide trapped charges (ΔN_{ot}), transconductance (g_m), mobility (μ), leakage current (I_L) and drain saturation current (I_{DSat}) were studied as a function of dose. A considerable increase in ΔN_{it} and ΔN_{ot} and decrease in V_{th}, g_m, μ, and $I_{D\ Sat}$ was observed after irradiation. The μ was correlated with ΔN_{it} and it is found that the contribution of ΔN_{ot} in degrading the mobility of charge carriers is negligible.The ion irradiated results were compared with Co-60 gamma irradiated results and found that the degradation is more for Co-60 gamma irradiated devices at lower doses, whereas at higher doses, the degradation is more for heavy ion irradiated devices.**

Index Terms—**N-channel DMOSFETs, swift heavy ion irradiation, ^{60}Co gamma, oxide trapped charges, interface trapped charges.**

I. Introduction

THE N – CHANNEL metal oxide semiconductor field effect transistors (MOSFETs) are the key components in advanced integrated circuits and are used in space, military and other radiation harsh environments such as accelerators where high and low energy particles exist [1]. The space consists of energetic protons, electrons and heavy ions originating from galactic cosmic rays, solar events from the Sun and protons and electrons trapped by the earth's magnetic field, i.e., Van Allen belts [2]. These particles bombard or strike the devices continuously and cause an accumulation of charges to build up at the sensitive interface, i.e., at Si/SiO_2 and thereby degrade the performance of devices. The systems operating in the above said environments are exposed to total doses ranging from 10's of krad to 10's of Mrad of radiation during their mission lifetime. Since there are ambiguities concerning the space environment and level of radiation tolerance of the devices, response of these MOS devices to different radiations still attracts the experimentalists who are dealing with the submicron technologies [2], [3], [31]. Evaluating the radiation hardness of a device with one radiation on the ground and predicting its response to different radiation in space is a complicated task. Thus, it is very essential to evaluate the radiation hardness of a device to different radiation from the application point of view [2].

Generally, Co-60 gamma radiation is the conventional irradiation source utilized to test the radiation hardness of the devices [4]–[5]. The irradiation time required to reach a high total dose using these conventional sources is very large. Recently, attempts have been done to use high energy swift heavy ions to study their total dose effects on SiGe HBTs and NPN transistors to reduce irradiation time. It was observed that high linear energy transfer (LET) ions degrade electronic devices more when compared to low LET ions [32]–[37]. Even though there is some literature available on swift heavy ion (SHI) irradiation effects on MOS devices, still there are ambiguities regarding the effects of different linear energy transfer (LET) ions on MOS devices under identical doses [6]–[9]. Therefore, larger area N-channel MOSFETs were exposed to 80 MeV Carbon (C^{6+}) and 80 MeV Nitrogen (N^{6+}) ions to understand the dependence of LET on the electrical characteristics of the irradiated devices. The results of ion irradiated MOSFETs were compared with the Co-60 gamma irradiated MOSFETs in the same dose ranges. Interestingly, high energy ion irradiated MOS devices show less degradation when compared to Co-60 gamma radiation.

II. Experimental Details

The cross-sectional view of a MOSFET (BEL 3N187) used in the present work is shown in Fig. 1. The 3N187 MOSFETs have two serially connected N-channels with independent dual gate with isolated silicon substrate (<100> 4-11ohm cm of thickness ~650 μm) and the gate oxide thickness (SiO_2) $\approx$ 750 nm. The metal (Al) of thickness $\approx$ 1.2 μm with device channel size $\approx$ 1.2 x 5 μm^2 and are sealed hermitically in the metal JEDEC TO-72 package [10]. The MOSFETs were irradiated with 80 MeV C^{6+} ions and 80 MeV N^{6+} ions with fluence ranging from 3.6 x 10^9 to 1.08 x 10^{12} C^{6+} ions/cm^2 and 2.4 x 10^9 to 7.14 x 10^{11} N^{6+} ions/cm^2respectively at Inter-University Accelerator Centre (IUAC), New Delhi using

Manuscript received September 18, 2019; accepted September 29, 2019. Date of publication October 3, 2019; date of current version December 18, 2019. This work was supported in part by the UGC-DAE Consortium for Scientific Research, Kolkata, India, under Project 13/MS01/0810. *(Corresponding author: A. P. Gnana Prakash.)*

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Color versions of one or more of the figures in this article are available online at http://ieeexplore.ieee.org.

Digital Object Identifier 10.1109/TDMR.2019.2945400

Nuclear Engineering and Technology 51 (2019) 1428–1435

Contents lists available at ScienceDirect

Nuclear Engineering and Technology

journal homepage: www.elsevier.com/locate/net

Original Article

High energy swift heavy ion irradiation and annealing effects on DC electrical characteristics of 200 GHz SiGe HBTs

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ARTICLE INFO

Article history:
Received 18 June 2018
Received in revised form
12 March 2019
Accepted 22 March 2019
Available online 29 March 2019

Keywords:
SiGe HBT
Ion irradiation
Gamma irradiation
Current gain degradation
Isochronal annealing
Recovery factors

ABSTRACT

The total ionizing dose (TID) and non ionizing energy loss (NIEL) effects of 100 MeV phosphorous (P^{7+}) and 80 MeV nitrogen (N^{6+}) ions on 200 GHz silicon-germanium heterojunction bipolar transistors (SiGe HBTs) were examined in the total dose range from 1 to 100 Mrad(Si). The *in-situ* I–V characteristics like Gummel characteristics, excess base current (ΔI_B), net oxide trapped charge (N_{OX}), current gain (h_{FE}), avalanche multiplication (M – 1), neutral base recombination (NBR) and output characteristics (I_C-V_{CE}) were analysed before and after irradiation. The significant degradation in device parameters was observed after 100 MeV P^{7+} and 80 MeV N^{6+} ion irradiation. The 100 MeV P^{7+} ions create more damage in the SiGe HBT structure and in turn degrade the electrical characteristics of SiGe HBTs more when compared to 80 MeV N^{6+}. The SiGe HBTs irradiated up to 100 Mrad of total dose were annealed from 50 °C to 400 °C in different steps for 30 min duration in order to study the recovery of electrical characteristics. The recovery factors (RFs) are employed to analyse the contribution of room temperature and isochronal annealing in total recovery.

1. Introduction

The SiGe BiCMOS technology plays a critical role in many electronic applications. The SiGe HBTs exhibit better parametric responses and excellent cryogenic performance when compared to Si BJTs. Along with this, the inherent robust TID tolerance up to multi Mrad (SiO_2) of total dose make them a suitable candidate for extreme environment applications [1–3]. In applications such as space systems, high energy physics experiment (HEP), military, medical facilities and nuclear installations these SiGe HBTs may be exposed to radiation. Therefore, parametric degradation and failures, in other words, the reliability of SiGe HBTs is an important aspect when operating in radiation rich environments. It is known that the ionizing radiation induces damages in both Si-SiO_2 interface and bulk silicon (Si) [2,3]. Therefore, it is useful to understand the mechanism and location of damages in the device structure and also the response of emitter-base (E-B) spacer and shallow trench isolation (STI) oxides to different radiation species, not only for scientific reason but also to examine the reliability and to design radiation-harden devices. Many researchers have studied the TID effects on different semiconductor devices [4–10]. However, most of those studies are focused on bipolar transistors and MOSFETs, mostly on gamma, proton and neutron irradiations [7,10,11]. Very few reviews on the performance and reliability of SiGe HBTs under the influence of high linear energy transfer (LET) swift heavy ions (SHI) irradiation are available. Sun et al. have studied the effects of different LET ions such as Si, Cl, Br on SiGe HBTs. They reported that degradation in the device characteristics is a function of fluence and also the biasing conditions [12–15]. The synergistic effect of total ionizing dose (TID) and single event effect (SEE) in SiGe heterojunction bipolar transistor (HBT) is investigated by Zhang et al. [16]. They observed that the influence of positive oxide-trap charges induced by TID on the distortion of electric field in SEE is the major factor of the synergistic effect. Moreover, the recombination of interface traps also plays a role in charge collection. Dong et al., have studied the annealing of point defects and their influence on the electrical degradation and recovery behaviours of irradiated SiGe HBTs. They observed that high concentrations of divacancy

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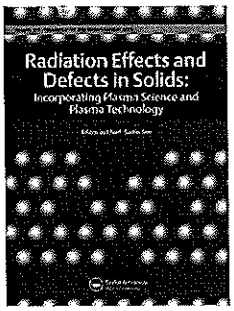
https://doi.org/10.1016/j.net.2019.03.016



Taylor & Francis
Taylor & Francis Group

Radiation Effects and Defects in Solids
Incorporating Plasma Science and Plasma Technology

ISSN: 1042-0150 (Print) 1029-4953 (Online) Journal homepage: https://www.tandfonline.com/loi/grad20

Swift heavy ions-induced degradation on the electrical characteristics of silicon NPN power transistors

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To cite this article: T. M. Pradeep, Vinayakaprasanna N. Hegde, N. Pushpa, Ambuj Tripathi, K. Asokan & A. P. Gnana Prakash (2019) Swift heavy ions-induced degradation on the electrical characteristics of silicon NPN power transistors, Radiation Effects and Defects in Solids, 174:9-10, 859-872, DOI: 10.1080/10420150.2019.1667356

To link to this article: https://doi.org/10.1080/10420150.2019.1667356

Published online: 20 Sep 2019.

Rajendraprasad and Basavaiah *Journal of Analytical Science and Technology* (2019) 10:37
https://doi.org/10.1186/s40543-019-0192-2

Journal of Analytical Science and Technology

RESEARCH ARTICLE Open Access

Development of membrane electrodes for selective determination of lisinopril in pharmaceuticals

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Abstract

Background: Lisinopril (LNP) is an angiotensin-converting enzyme inhibitor used as anti-hypertensive, cardiovascular, in anti-prophylactic and anti-diabetic nephropathy drug. Development of two new, simple, low cost, and selective membrane-based ion-selective electrodes has been proposed for the determination of LNP in pharmaceuticals.

Methods: The electrodes are based on poly(vinyl)chloride membrane doped with LNP-phosphotungstic acid (LNP-PTA) and LNP-phosphomolybdic acid (LNP-PMA) ion-pairs as molecular recognition materials.

Results: The developed LNP-PTA and LNP-PMA electrodes are applicable for the determination of LNP over the linear range of 5×10^{-5}–2.4×10^{-3} mol l^{-1}. The working pH ranges to measure potentials were 2.5 to 6.4 and 2.3 to 6.0 for LNP-PTA and LNP-PMA ISEs, respectively. The electrodes displayed the rapid Nernstian responses as revealed by the values of slopes 55.06 and 52.39 mV/decade, with limit of detection (LOD) values of 1.2×10^{-5} and 1.18×10^{-5} mol l^{-1} for LNP-PTA and LNP-PMA electrodes, respectively. The limits of quantitation (LOQ) values have also been calculated for both the electrodes. The developed electrodes have potential stability for up to 1 month and emerged as highly selective for the determination of LNP over other spiked ions and compounds.

Conclusions: The proposed electrodes have been validated and found that they are suitable for the determination of LNP in pharmaceuticals in pure form and in dosage forms. The results obtained in the analysis of LNP using proposed electrodes have been compared statistically with reference method's results to assess the accuracy and precision. Robustness and ruggedness of the developed electrodes have also been checked and found satisfactory. The recovery studies have been performed by standard addition procedure to assess the role of excipients in tablets containing LNP and the results obtained are satisfactory.

Keywords: Lisinopril, Cardiovascular drug, Ion-selective electrode, Pharmaceuticals

Background

Lisinopril (LNP) {1-[6-Amino-2-(1-carboxy-3-phenyl-propylamino)-hexanoyl]-pyrrolidine-2-carboxylic acid} (Fig. 1) is an angiotensin-converting enzyme inhibitor used in the treatment of hypertension and heart failure, in prophylactic treatment after myocardial infarction, and in diabetic nephropathy (Parfitt, 1999). Historically, LNP was the third ACE inhibitor, after captopril and enalapril, and was introduced into therapy in the early 1990s (Patchett et al. 1980).

The drug LNP is official in the British (BP) (The British Pharmacopoeia, 1998) and United States (US) pharmacopoeias (The US Pharmacopoeia, 2000). The British Pharmacopoeia (BP) describes a monograph of potentiometric titration of aqueous solution of the tablet containing LNP with 0.1 M NaOH and US Pharmacopoeia (USP) describes a chromatographic procedure for assay of LNP using C-8 (octylsilyl-silane) column at 50 °C and phosphate solution-acetronitrile (96:4 v/v) as mobile phase with UV detection at 215 nm.

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Applied Chemical Engineering (2019) Volume 2
doi:10.24294/ace.v2i2.179

Use of Sodium Tetraphenyl Boron for Fabrication of Potentiometric Membrane Sensor for the Assay of Olanzapine in Pharmaceuticals and Human Urine

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ABSTRACT

Olanzapine (OLP), chemically known as 2-Methyl-10-(4-methyl-piperazin-1-yl)-4H-3-thia-4,9-diaza-benzo[f]azulene, is an atypical antipsychotic drug. It is used for the treatment of schizophrenia and bipolar disorder. A new simple and selective membrane based potentiometric sensor was developed for potentiometric determination of olanzapine. The membrane was constructed using an ion-pair of OLP and sodium tetraphenyl boron in dioctyl phthalate and PVC. The membrane provides good linear Nernstian response covering relatively wide concentration range of 4×10^{-6} - 1×10^{-2} M OLP over pH range of 2.6-7.8. The detection limit for the developed sensor was founded as 2.02×10^{-6} M. The response time of developed sensor is <10 s for the range of determination. The sensor showed good selectivity for OLP in the presence of various cations, anions and other organic molecules. The membrane was successfully applied in direct potentiometric determination of OLP in tablets. The percentage recovery of OLP, ranged from 96.2 to 99.68% with a mean standard deviation <5% indicates the adoptability of sensor for the direct estimation of OLP in pharmaceuticals. The developed sensor was used to determine OLP in spiked human urine sample and the satisfactory results were obtained.

Keywords: Olanzapine; Membrane Sensor; Assay; Pharmaceuticals; Spiked Human Urine

1. Introduction

Olanzapine (OLP), chemically known as 2-Methyl-10-(4-methyl-piperazin-1-yl)-4H-3-thia-4,9-diaza-benzo[f]azulene (**Figure 1**), is the most commonly prescribed second generation neuroleptic agent for the treatment of schizophrenia and other psychotic disorders.

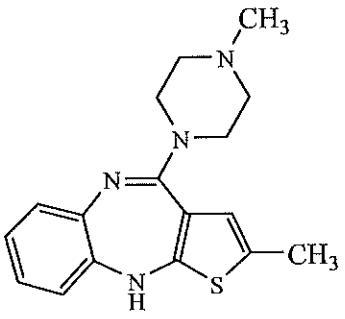

Figure 1; Structure of OLP.

In the literature titrimetry[1-3], visible spectrophotometry[3-10], kinetic spectrophotometry[11], UV-spectrophotometry[2,12], capillary zone electrophoresis and linear voltammetry[12] and high-performance thin layer chromatography (HPTLC)[13-15] have been reported for determination of OLP in pharmaceuticals. Several liquid chromatographic methods[16-33] have also been reported for the assay of OLP in pharmaceuticals and biological materials.

Research in the field of development of potentiometric sensors is gaining an increasing number of attention and numerous potentiometric sensors have been developed for the determination of species in the areas of chemical, pharmaceutical and biomedical analyses[34-45]. Potentiometric sensors offers advantages as their use to quantify the compounds since they neither need sophisticated instrument nor relying on stringent experimental conditions.

As presented above literature did not reveal the report for determining OLP with potentiometric sensor.

doi: 10.24294/ace.v2i2.177

Current Chemistry Letters 8 (2019) 87–96

Contents lists available at GrowingScience

Current Chemistry Letters

homepage: www.GrowingScience.com

Novel membrane sensor for determination of lamotrigine in pharmaceuticals and urine

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CHRONICLE

Article history:
Received July 28, 2018
Received in revised form
February 20, 2019
Accepted February 20, 2019
Available online
February 22, 2019

Keywords:
Membrane sensor
Lamotrigine
Potentiometric determination
Pharmaceuticals
Spiked human urine

ABSTRACT

Lamotrigine (LMT), chemically known as [6-(2,3-dichlorophenyl)-1,2,4-triazine-3,5-diamine], is a broad spectrum antiepileptic drug, used as monotherapy and as an adjunct with other antiepileptic drugs for treatment of partial and generalized toxic-clonic seizures. It is used to treat neurological lesions and as a tranquilizer. A selective electrochemical membrane sensor has been developed and validated for determination of LMT. The membrane constructed using LMT and molybdophosphoric acid in THF and PVC is applicable for the detection of 5×10^{-4} to 9×10^{-3} M LMT in the pH range between 4.6 and 5.8 with the Nernstian slope of 57.14±1 mV/decade. The regression coefficient value of 0.9932 showed a good linear correlation between the concentrations of LMT and measured cell potentials. The limits of detection (LOD) and quantification (LOQ) values for the fabricated sensor were 1.3×10^{-5} and 4×10^{-5} M LMT, respectively. Various experimental conditions were optimized to reach the effective performance characteristics of the sensor. The effect of various cations, anions and organic species on the performance of sensor was studied by following standard-addition procedure. The results revealed no such variations due to presence of foreign ions or species. The fabricated sensor was subjected to validation to check accuracy, precision, robustness and ruggedness. The mean accuracy for determination of LMT was found to be 99.16%. The developed sensor was successfully used to determine LMT in tablets and in spiked human urine.

1. Introduction

Lamotrigine (LMT) is chemically known as 3,5-diamino-6-(2,3-dichlorophenyl)-as-triazine (**Fig. 1**), is an anticonvulsant drug used in the treatment of epilepsy and bipolar disorder. It is also used off-label as an adjunct in treating clinical depression.

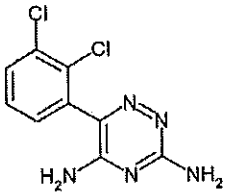

Fig. 1. Chemical structure of LMT

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doi: 10.5267/j.ccl.2019.002.002

Inorganica Chimica Acta 484 (2019) 227–236

Contents lists available at ScienceDirect

Inorganica Chimica Acta

journal homepage: www.elsevier.com/locate/ica

Research paper

Synthesis and structural studies of 1-phenyl-1,3-butanedione copper(II) complexes as an excellent antimicrobial agent against methicillin-resistant *Staphylococcus aureus*

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ARTICLE INFO

Keywords:
Copper(II) complex
β-Diketone
Antibacterial activity
MRSA
Biocompatibility

ABSTRACT

The copper based metal complexes (CMC) were synthesized using 1-phenyl-1,3-butanedione with two different solvents, methanol and water:acetic acid. The X-ray structural analysis of the two CMCs indicates that, coordination environment around the complex **1** $[Cu(C_{10}H_{10}O_2)_2(CH_4O)]$ exhibits distorted square-pyramidal geometry with *trans*-isomer favored structure whereas complex **2** $[Cu(C_{10}H_{10}O_2)_2]$ exhibits distorted square-planar geometry with *cis*-isomer favored structure. Both copper complexes were characterized by SEM, EDX, Mass and TGA. Further, the CMCs were showed promising antibacterial activity by disc diffusion and minimum inhibitory concentration assay against Gram positive and Gram negative bacteria. The studied model showed CMC were potent against methicillin-resistant *Staphylococcus aureus* (MRSA) validated by inhibition of electron transport chain. The formation of membrane pore/damage by CMC leads to changes in the bioelectrochemistry of the MRSA was assessed and mechanism involved in membrane damage was confirmed by SEM. The study concludes that the complex **1** showed potent antibacterial action compared to standard drug ampicillin.

1. Introduction

In the field of bioinorganic chemistry, designing biological interest molecules is 'hot area' of research [1]. The proper design of organic ligands and also chelation with suitable metal ions enhance the biological efficacy [2]. The metal ions such as platinum, titanium, ruthenium, gold, copper, silver and their complexes showed good biological activity like antitumor, antiamoebic, antihistaminic, anthelmintic, antiulcer, antimicrobial, anticancer and antihypertensive agents [1–4]. The selection of simple ligands can give rise to biologically important complex materials in which, such a class of ligand is the β-diketone [5–11]. A wide variety biological application of β-diketones viz., antimicrobial [5], antitumor [6,7], anticonvulsants [8], antioxidant [9], antiinflammatory [10], antiulcer [11] and antihypertensive [12]. The metallo drugs are toxic, therefore to overcome that, drugs based on essential metals have proposed, which led to investigation of copper based antimicrobial drugs. [13–15]. It is well known that the copper has wide applications in medicine [13], pesticides [14], fungicides [15], catalysis [16] and anticancer agents [17]. Copper complexes are effective antimicrobial agent and have gained much interest due to their multitoxicity in nature towards multiresistant germs like "super bug" MRSA and carbapenemase-resistant bacteria [18]. Therefore, it is envisaged that by combining copper and β-diketones would result in enhanced antimicrobial activity was expected.

Recent years, the microbial infections have drastically increased and deployment of antibiotics causes a life treating infectious diseases and led to the emergence of resistance among the various strains of microorganisms. The aforecited studies and findings strongly motivate further research on the antibacterial copper metal complexes. We present herein the synthesis, spectral, thermal characterization and crystal structures of 1-phenyl-1,3-butanedione copper(II) complexes with different coordination number for the first time, which reveals the geometrical environment around the central copper(II) metal ion. Hirshfeld surface analysis was studied to understand the intermolecular

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https://doi.org/10.1016/j.ica.2018.09.049
Received 6 April 2018; Received in revised form 10 September 2018; Accepted 20 September 2018
Available online 21 September 2018

International Journal of Pharmacy and Biological Sciences-IJPBS™ (2019) 9 (3): 1262-1268
Online ISSN: 2230-7605, Print ISSN: 2321-3272
Research Article | Biological Sciences | Open Access | MCI Approved
UGC Approved Journal

Synthesis, Characterization of 4-Nitrobenzamide Derivatives and their Antimicrobial Activity

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Received: 17 Mar 2019 / Accepted: 19 Apr 2019 / Published online: 1 Jul 2019
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Abstract

New 4-nitrobenzamide derivatives, 3(a–d) and 3(a_1–d_1) were synthesized and structurally characterized by various spectroscopic techniques such as ^{1}H-NMR, ^{13}C NMR, LCMS and FT-IR spectral studies. All compounds were evaluated for *in vitro* antimicrobial activity. Compounds 3a and 3a_1 were found to be most active and compared to the other synthesized compounds. Compounds 3a and 3a_1 could be a potential antimicrobial agent and these deserve further research.

Keywords
Schiff base, 4-nitrobenzamide, antimicrobial activity.

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INTRODUCTION

A Schiff base is derived from aromatic amines and aromatic aldehydes have a wide range of applications in various fields, example biological, inorganic and analytical chemistry [1-5]. A Schiff base is nitrogen analogue of an aldehyde or ketone wherein the C=O group replaced by a C=N-R cluster. Schiff bases that contain aryl substituents are significantly more stable and more rapidly synthesized, while those which contain alkyl substituents are relatively unstable.

Schiff bases are used in optical and electrochemical sensors, as well as in various chromatographic methods, to enable detection of enhance selectivity [6-8]. Among the organic reagents used, Schiff bases possess excellent characteristics, structural similarities with natural biological substances, relatively simple preparation procedures and the synthetic flexibility that enables design of suitable structural properties [9, 10].

Unfortunately, most Schiff bases are chemically unstable and show a tendency to be involved in various equilibria, like interconversions, hydrolysis,

Contents lists available at GrowingScience

Current Chemistry Letters

homepage: www.GrowingScience.com

Synthesis and characterization of Schiff base analogues of fluoroaniline and their antibiocidal activity against MRSA

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CHRONICLE

Article history:
Received September 18, 2018
Received in revised form
April 12, 2019
Accepted April 21, 2019
Available online
April 22, 2019

Keywords:
Schiff base
Fluoroaniline
Antibacterial activity
MRSA

ABSTRACT

A group of new fluoroaniline Schiff bases (**3a–3f**) were synthesized and structurally characterized by various spectroscopic techniques such as ^{1}H-NMR, LC-MS and FT-IR spectral studies. All compounds were evaluated for *in vitro* antibacterial activity. Compounds exhibited good to moderate antibacterial activity. Compound **3f** (Zone of Inhibition = 10.08±0.06 μM) was found to be the most active one, and comparable to the standard Streptomycin (IC_{50} = 15.95±0.08 μM). The compounds having chloro substituent exhibit good membrane damage property against Methicillin-resistant Staphylococcus aureus (MRSA) confirmed by SEM analysis. Structure-activity relationship (SAR) was rationalized by looking at the varying structural features of the molecules.

1. Introduction

Schiff bases (imine or azomethine, –C=N-), are formed by condensation of precursors of amine and carbonyl groups[1-2]. These Schiff bases are having broad spectrum of applications in various fields such as sensors[3], paints[4] and as polymer stabilizers[5].The Schiff base probes are used for various metal ion detection[6]. Schiff bases have additionally been appeared as biologically potent pharmacophore such as antimicrobial[7], antimalarial, anticonvulsant, antiviral, antioxidant, antiproliferative[8], analgesic and antipyretic properties[9]. Therefore, Schiff base candidate plays a vital role in the medicinal and pharmaceutical chemistry field. The effective bioactivity of these imines is for the most part credited to the alkyl/aryl/heteroaryl gather with multi substituent in the molecule, whereas Schiff base are one center or appended[10,11]. These promoted researchers to design new Schiff base for the desired applications.

Staphylococcus aurous[12] is perceived as a standout amongst the most widely recognized pathogens in charge of nourishment harming and causing different diseases in creature and humans[12,13]. This facultative anaerobe is a characteristic vegetation in 20– 30% of individuals, show inside the front nares and on the skin[14]. Disease happens for the most part by avoidance of invulnerable framework in the host to cause pneumonia, aspiratory tuberculosis, endocarditis, sepsis, delicate tissue contaminations

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doi: 10.5267/j.ccl.2019.004.005

Bioorganic & Medicinal Chemistry 27 (2019) 841–850

Contents lists available at ScienceDirect

Bioorganic & Medicinal Chemistry

journal homepage: www.elsevier.com/locate/bmc

A novel copper (II) PAmPiCaT complex (cPAmPiCaTc) as a biologically potent candidate: A contraption evidence against methicillin-resistant *Staphylococcus aureus* (MRSA) and a molecular docking proof

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ARTICLE INFO

Keywords:
Copper complex
Piperazine
MRSA
SarA and *DHFR*

ABSTRACT

Increasing in the alarm against the resistant bacteria due to the failure of antibiotics, thereby the need of more efficiency/potent molecule to treat infections. In the present investigation, series of piperazine derivatives 5(a-l) compounds were synthesized and they were characterised by different spectral techniques such as ^{1}H NMR, ^{13}C NMR, IR and LCMS. A novel copper complex (cPAmPiCaTc) was developed for the first time by using potent analog 5e and characterized by IR and LCMS. The cPAmPiCaTc evaluated for antibacterial activity and showed excellent antimicrobial effect (12 ± 0.08 mm, ZOI) at MIC 20 μg/mL against MRSA compared to standard antibiotics streptomycin and bacitracin at MIC 10 μg/mL. The results show promising anti-*staphylococcal* action against MRSA which confirmed by membrane damage, bioelectrochemistry, gene regulation (*SarA* and *DHFR*), and in silico molecular docking studies. Further, the cPAmPiCaTc also showed excellent blood compatibility and this result pave the way for interesting metallodrug therapeutics in future against MRSA infections.

1. Introduction

The *Staphylococcus aureus* (*S. aureus*) is one of the dangerous human pathogens causing major hospital and non-hospital infections (minor skin infections to major bacteremia) which leads to death due to improper treatment.[1] Humans harbor the *S. aureus* through skin and mucosa without adverse effect but, its integrity breached, *S. aureus* may have a chance to invade tissue and blood stream to cause life threatens. Many *Staphylococcal* strains developed resistance to a number of beta-lactam antibiotics to become methicillin-resistant *S. aureus* (MRSA).[2] The adaptability of *S. aureus* to common antibiotics leads to the development of hypervirulent and multidrug-resistant strains, which *S. aureus* becomes resistant all available antibiotics. Further, this drives a reduced market life of available drugs and decreases the profit value due to shorten treatment life of antibiotics. These types of attempts in *Staphylococcal* vaccine development, unfortunately, failures demonstrated by clinical data.

It is well-known fact that, the metal had a great lead in medicine from past 5000 years.[3] In the field of metallodrugs, inorganic medicinal chemistry constantly growing and gained much attention from the past 50 years but it is less fully understood and developed compared to the traditional medicinal chemistry with small organic or biological drug molecules.[4] The majority of the clinically approved drugs are quite old or despite their toxic nature used in the neglected disease (melarsoprol against human African sleeping sickness) in developing countries. For which advanced treatment options with fewer side effects have not yet developed. The metal complexes containing active ligands will provide a new powerful avenue, which is important for the target specific-drug development especially cancer,[5] infectious diseases,[6] and diabetes etc.[7] Among 91 of metals, 30 are heavy metals and a small amount of them are being used in the diet to maintain the magnitude of human health but at higher doses, some of them are toxic.[8] The copper bio-metal showed significant synergistic role against cancer,[9] bacterial,[10] diabetes[11] and Alzheimer's disease[12] etc. To develop such metal-based therapeutically active complexes, it is very important to choose the ligand of interest which involved in impairing the functionality to tune the final properties of the complex.[13]

Currently, many metal-containing compounds are the leading candidates and offering a wide range of advantages over conventional carbon-based compounds in the development of medicinal compounds. The excellent coordination of ligands into three-dimensional configurations allows the active groups to functionalize and tailored to definite molecular targets.[14] Several interesting works focused on copper (II) complex, which has treatment options against many diseases due to

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https://doi.org/10.1016/j.bmc.2019.01.026
Received 29 December 2018; Received in revised form 21 January 2019; Accepted 24 January 2019
Available online 28 January 2019

Available online at www.joac.info

ISSN: 2278-1862

Journal of Applicable Chemistry

2019, 8 (1): 89-96

(International Peer Reviewed Journal)

Synthesis of 1,2,4-triazole Derivatives and their Anticonvulsant Activity

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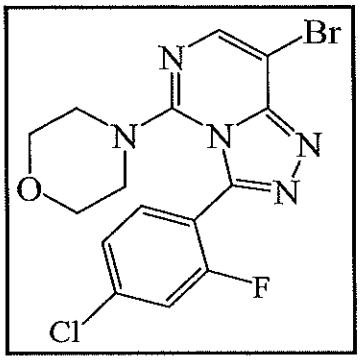
Accepted on 2nd January, 2019

ABSTRACT

A synthesis of a series of 1,2,4-triazole derivatives ***(5a-g)*** *have been accomplished in excellent yields by an oxidation of pyrimidinylhydrazines of various aryl carbaldehydes with iodobenzene diacetate. The chemical structures of the synthesized compounds were confirmed by FT-IR, ^{1}H NMR, ^{13}C NMR and mass spectral studies. All the compounds were screened for their anticonvulsant activity against maximal electroshock (MES) seizure method and their neurotoxic effects were determined by rotorod test. Compound* ***5f*** *was found to be the most potent of this series. The same compound showed no neurotoxicity at the maximum dose administered (100 mg kg^{-1}).*

Graphical Abstract



A series of 1,2,4-triazole derivatives (5a-g) synthesized among them 5f was found to be most potent.

Keywords: Pyrimidine, Iodobenzene diacetate, Aldehydes, Characterization, Anticonvulsant activity.

Microbial Pathogenesis 127 (2019) 106–115

Contents lists available at ScienceDirect

Microbial Pathogenesis

journal homepage: www.elsevier.com/locate/micpath

New approach to address antibiotic resistance: Miss loading of functional membrane microdomains (FMM) of methicillin-resistant *Staphylococcus aureus* (MRSA)

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ARTICLE INFO

Keywords:
Piperazine
Pthalamide
MRSA
Antibiotic resistance
Membrane disassembly

ABSTRACT

The synthesized potent piperazine analog ChDiPiCa was characterised by various spectroscopic techniques and for the first time evaluated functional membrane microdomain (FMM) disassembly in methicillin-resistant *Staphylococcus aureus* (MRSA). The ChDiPiCa showed excellent in vitro biocidal activity against MRSA at 26 μg/mL compared to the antibiotic streptomycin and bacitracin 14 μg/mL and 13 μg/mL at 10 μg concentration respectively. The membrane damaging property was confirmed by the SEM analysis. Further, we addressed the new approach for the first time to overcome antibiotic resistance of MRSA through membrane microdomain miss loading to lipids. By which, the ChDiPiCa confirms the significant activity in miss loading of FMM of MRSA which is validated by the fatty acid profile and lipid analysis. The result shows that, altered saturated (Lauric acid and Myristic acid), mono unsaturated (Oleic acid), and poly unsaturated (Linoleic acid and Linolenic acid) fatty acids and hypothesises, altered the membrane functional lipids. For the better understanding of miss loading of FMM by the ChDiPiCa, the *in-silico* molecular docking studies was analyzed and confirmed the predicted role. This suggests the way to develop ChDiPiCa in medicinal chemistry as anti-MRSA candidates and also this report opens up new window to treat microbial pathogens and infections.

1. Introduction

Staphylococcus aureus is a Gram-positive and one of the most notorious ESKAPE (*Enterococcus faecium, Staphylococcus aureus, Klebsiella pneumoniae, Acinetobacter baumanii, Pseudomonas aeruginosa,* and *Enterobacter species*) clinical bacterial pathogenscolonizes 30% of healthy human individuals, causing community-acquired and nosocomial infections worldwide [1–4]. Since 1948, the first discovery of antibiotic methicillin and bacteria *S. aureus* acquired a resistance determinant called '*mecA*' in its genome to become methicillin-resistant *S. aureus* (MRSA) and quickly become predominant master infectious pathogen with increased global prevalence [1]. Because of its higher drug-resistance rate, now MRSA becoming global problem to treat, which leads to higher morbidity and mortality than the methicillin-susceptible *S. aureus* (MSSA) [5–7].Notorious MRSA evolved with a wide range of strategies to colonize and invade human system to cause death, despite the presence of multiple host defence mechanisms. The death rate was increased from 700,000 per year, and it become 10 million by 2050; hence, MRSA was renamed as "super bug" [8,9].

Diverse fields approaching new improvements in discovery and development of new antibacterial compounds but, due to cost and microbial resistance it has been slow and arsenal effective antibiotics were diminishing [10].Many classes of antibacterial drugs were approved by the Food Drug Administration (FDA) from 1939 to 2017 such as Sulfonamides, Aminoglycosides, Penicillins, Tetracycline, Polypeptides, Lincosamides, Oxazolidinones, Quinolones, Macrolides, Cephalosporins, Rifamycins, Tuberactinomycins, Carbapenems, Glycopeptides, Monobactams, Streptogramins, Lipoglycopeptides, Lipopetides, and Macrocyclins are the leaders in the antibiotics [11]. These types of antibiotics common mechanism by act on bacterial target sites such as cell wall (β-lactams- Ceftaroline), cell membrane (Daptomycin), cell wall and cell membrane (Semisynthetic lipoglycopeptides- Telavancin), DNA and/or RNA synthesis (Fluroquinolones- Delafloxacin), protein synthesis (licosamides- Tedizolid targeting 50S ribosome; tetracyclines- Eravacycline), and folate synthesis (sulphonamides- Sulfamethoxazole; folate inhibitors- Trimethoprim) [12]. Due to unintended consequences of antibiotic misuse and overuse, cited as major driving force to develop resistance in one of human pathogen MRSA. The lack of effective

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https://doi.org/10.1016/j.micpath.2018.11.038
Received 17 September 2018; Received in revised form 22 November 2018; Accepted 26 November 2018
Available online 29 November 2018
0882-4010/

International Journal of Peptide Research and Therapeutics
https://doi.org/10.1007/s10989-019-09883-7

caP4: A 2.97 KDa Cationic Antibacterial Peptide from *Curcuma pseudomontana* L.

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Accepted: 25 June 2019

Abstract
The present investigation reports the sequence of a 2.97KDa low molecular weight, cationic antibacterial peptide, *caP4* isolated from wild variety of turmeric, *Curcuma pseudomontana* L. (Zingiberaceae). The *rp*-HPLC of 80% saturated ammonium sulphate protein precipitate showed four peaks labelled P1, P2, P3 and P4. The peak fraction, P4 eluted at 39.73 min showed 63.47% and 43.27% inhibition against *E. coli* and *S. aureus* respectively. The P4 was found to be stable at − 20 °C to 65 °C, in pH from 7.0 to 10.0 and retained antibacterial activity when treated with proteases. The MIC of P4 varied for different bacterial strains between 10 and 30 mg/L. Biofilm formation of *P. aerugenosa* and *S. aureus* was declined to 90% and 50% respectively at 20 µg of P4. The P4 on UPLC-MS yielded single major peak (with retention time of 1.98 min). The peak fraction was pooled and analysed using ESI-MS/MS, showing peptide masses ranging from 400 to 1800 Da. Further, *Tof* MS/MS-ESI of two intense peak yielded the sequences ASSCKPS (mass 1.16KDa) and ASSKWVAPSEW (mass 1.81 kDa) with a total mass of 2.97KDa, designated as *caP4* (cationic peptide of Peak 4) having a net charge of +1 and hydrophobicity ranging from 18 to 22%. The above results show that *caP4* could possibly be used as antibacterial peptide with significant therapeutic index.

Keywords *Curcuma pseudomontana* L. · Cationic antibacterial peptide · Agar diffusion assay · Biofilms · Therapeutic peptides

Introduction

Throughout history humans have attempted to alleviate suffering by treating disease often by taking different formulations of plant extracts as a remedy for the disease or an infection. The 20th century belonged to "Chemistry era" where lead molecules were either isolated from natural sources or chemically synthesising small molecules with the knowledge of chemistry that included rational design, ligand based, mechanism based or receptor based design (David et al. 2013). Advancement in screening and design technologies in the field of pharmacology has set an interesting bench mark for future drug development. The time management from drug discovery to drug registration and economy has taken the 21st century to invincible technological revolution. Since the last decade of the 20th century, increase of bacterial resistance to commercial antibiotics and the increased restriction on the use of chemical preservatives in foods have greatly stimulated the search for novel alternative natural antimicrobial agents that possess a broad spectrum of antibiotic activity (Delves-Broughton 1990). Drugs that have become resistant to a group of microorganisms named as ESKAPE are found responsible for majority of hospital infections spread across the globe. These organisms have become resistant to most recent antibiotic carbapen in Pseudomonas and Acinetobacter species (Natalia et al. 2017). Moreover, the bacterial biofilm formation is an important survival mechanism that offers more resistant to conventional antibiotics (Joelle and Maxwell 2018). Hence, a new branch of biologic drugs named "Bioactive peptides" has gained tremendous significance in recent years.

Many peptide based therapies have been used by man to overcome disorder and diseased condition since many decades that include insulin for diabetes, calcitonin and

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Published online: 01 July 2019

Volume 9, Issue 4, 2019, 4015 - 4021 ISSN 2069-5837

Biointerface Research in Applied Chemistry

www.BiointerfaceResearch.com

https://doi.org/10.33263/BRIAC94.015021

Original Research Article **Open Access Journal**

Received: 17.06.2019 / Revised: 03.08.2019 / Accepted: 10.08.2019 / Published on-line: 15.08.2019

Molecular docking and multitudinous spectroscopic studies to elucidating proton-pump inhibitor a lansoprazole binding interaction with bovine serum albumin

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ABSTRACT

A carrier protein called bovine serum albumin (BSA) interaction with proton-pump inhibitor such as lansoprazole (LSE) has been investigated at 295, 303 and 311 K in pH 7.40 by docking and [UV–vis, CD, FT–IR and fluorescence (emission, 3D and synchronous)] spectroscopic studies. Emission fluorescence has suggested LSE–BSA complex formation by static quenching with strong binding. This interaction has proceeded by Vander Waals and hydrogen bonding. An observation from competitive site marker and docking experiments has resulted in binding of LSE with BSA transpired at site II, whereas from Förster's theory a binding distance (r) was retrieved to be 0.19 Å from LSE to Trp of BSA. Change in conformation, secondary structure and microenvironment of BSA were noticed after LSE interaction. Diminished binding constant in Zn^{2+}, Na^{+}, Fe^{2+}, Ca^{2+} and Co^{2+} ions presence on LSE-BSA interaction was also identified.

Keywords:*Bovine serum albumin, Binding studies, various fluorescence spectroscopy, Lansoprazole, Molecular docking.*

1. INTRODUCTION

Typical drug properties (metabolism, distribution, excretion and absorption) are significantly impacted by protein-drug binding. Wide assortments of organisms in the system of circulatory, serum albumins are exceedingly abundant proteins furnishes to osmotic blood pressure as being major macromolecule are also established in bodily secretions and tissues anywhere in the body; total albumin was comprised of extra-vascular protein about 60%. The current work is chosen BSA (Fig. 1A) as protein demonstrates due to its therapeutic significance, ready availability, unordinary ligand-binding properties and minimal cost [1, 2].

Lansoprazole (LSE) is medication to reduce long-lasting and pronounced acid from stomach production. LSE (Fig. 1B) is also used to treat indigestion, heartburn, persistent cough and difficulty in swallowing. LSE can block the enzyme at stomach wall that produces acid. The decreased acid production by enzyme blocking was allowed esophagus and stomach to heal. The fundamental side effects encircle blood disorders (leukopenia, pancytopenia, leukocytosis and thrombocytopenia), skin reactions (toxic epidermal necrolysis, erythroderma Stevens-Johnson syndrome and bullous eruption), myalgia, arthralgia, liver dysfunction, taste disturbance and peripheral oedema [3-5].

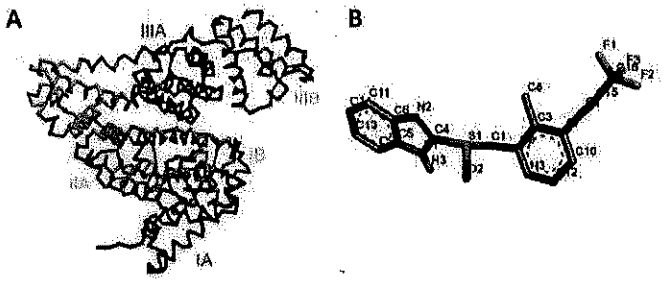

Figure 1.BSA (A) and LSE (B) three dimensional structures.

Functional and structural relationships of LSE under physiological circumstances can interact with BSA by molecular docking and numerous spectroscopic approaches were initiated to comprehend in this work. Effects of Zn^{2+}, Na^{+}, Fe^{2+}, Ca^{2+} and Co^{2+} ions on LSE–BSA interaction were inspected. Molecular basis and characterized chemical association resulted from these interaction investigations.

2. MATERIALS AND METHODS

2.1. Chemicals and stock solutions. LSE (≥98%, TLC), BSA (≥98%, chromatographically purified), digitoxin (≥92%, HPLC), ibuprofen (≥98%, GC), warfarin (98%, analytical standard), zinc chloride (≥99.999%, trace metal basis), sodium chloride (≥99%, ACS reagent), iron(II) sulphateheptahydrate (≥99%, ACS reagent), calcium chloride (≥93.0%, trace metal basis) and cobalt chloride hexahydrate (≥98%, ACS reagent) were procured from Sigma-Aldrich. The analytical standard was exploited for other chemicals. A stock solution of 1.0×10^{-3}mol L^{-1} was made for site markers, LSE and metal ions whereas 1.0×10^{-4}mol L^{-1} for BSA. All over experiments, Tris buffer (pH 7.40) prepared from double-distilled water was employed with proper background corrections.

2.2. UV-Vis measurements. DU 730 UV – visible Spectrophotometer (Life Sciences, Beckman Coulter, USA) was employed to BSA (3.30×10^{-6}mol L^{-1}) and LSE–BSA system to record absorption spectra at 303 K in 200–320 nm wavelength region. The concentration of LSE was varied from 0.0, 0.55, 1.10 up to 5.50 ($\times 10^{-6}$mol L^{-1}).

2.3. Circular dichroism spectral determinations. CD spectrum was come off on a Jasco circular dichroism spectropolarimeter (815, Japan) at 303 K for BSA (3.30×10^{-6}mol L^{-1}) and

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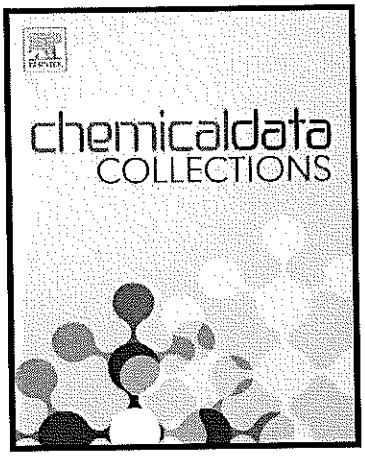


Microwave induced synthesis, and pharmacological properties of novel 1-benzoyl-4-bromopyrrolo[1,2-a]quinoline-3-carboxylate analogues

Vijayakumar Uppar , Kiran K. Mudnakudu-Nagaraju , Atiyaparveen I. Basarikatti , Mallikarjun Chougala , Sandeep Chandrashekharappa , Mahendra K. Mohan , Govindappa Banuprakash , Katharigatta N. Venugopala , Raghu Ningegowda , Basavaraj Padmashali

PII: S2405-8300(19)30437-9
DOI: https://doi.org/10.1016/j.cdc.2019.100316
Reference: CDC 100316

To appear in: *Chemical Data Collections*

Received date: 6 November 2019
Revised date: 26 November 2019
Accepted date: 4 December 2019

Please cite this article as: Vijayakumar Uppar , Kiran K. Mudnakudu-Nagaraju , Atiyaparveen I. Basarikatti , Mallikarjun Chougala , Sandeep Chandrashekharappa , Mahendra K. Mohan , Govindappa Banuprakash , Katharigatta N. Venugopala , Raghu Ningegowda , Basavaraj Padmashali , Microwave induced synthesis, and pharmacological properties of novel 1-benzoyl-4-bromopyrrolo[1,2-a]quinoline-3-carboxylate analogues, *Chemical Data Collections* (2019), doi: https://doi.org/10.1016/j.cdc.2019.100316

Journal of Fractional Calculus and Applications
Vol. 10(2) July 2019, pp. 216-224.
ISSN: 2090-5858.
http://math-frac.oreg/Journals/JFCA/

ON CERTAIN SUBCLASSES OF ANALYTIC FUNCTIONS WITH RIEMANN LIOUVILLE q-DERIVATIVE DISTRIBUTION SERIES

N. RAVIKUMAR, S. LATHA, B.A. FRASIN

ABSTRACT. By making use of the concepts of fractional q- calculus, we define the subclasses $\mathcal{S}_p^q(\alpha,\beta,\delta,b)$ and $\mathcal{TS}_p^q[\alpha,\beta,\delta,b]$ of analytic function. For functions belonging to these classes, we obtain coefficient estimates, distortion bounds and many more properties.

1. INTRODUCTION

The fractional q-calculus is the extension of the ordinary fractional calculus in the q-theory. The theory of q-calculus operators in recent past have been applied in the areas of ordinary fractional calculus, optimal control problems and in finding solutions of the q-difference and q-integral equations, and in q-transform analysis and also in the geometric function theory of complex analysis. For more details on the subject, one may refer to [6], [1], [3], [9] and [16].

Let $\mathcal{S}$ denote the family of functions of the form

$$f(z) = z + \sum_{m=2}^{\infty} a_m z^m \tag{1}$$

which are analytic in the open unit disc $\mathcal{U} = \{z : |z| < 1\}$. Also denote by $\mathcal{T}$, the subclass of $\mathcal{S}$ consisting of functions of the form

$$f(z) = z - \sum_{m=2}^{\infty} |a_m| z^m \tag{2}$$

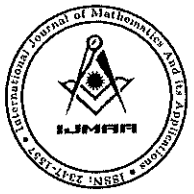
which are univalent and normalized in $\mathcal{U}$. For $f \in \mathcal{S}$ and of the form (1) and $g(z) \in \mathcal{S}$ given by $g(z) = z + \sum_{m=2}^{\infty} b_m z^m$, we define the convolution (or Hadamard product) $f * g$ of two power series f and g by $(f * g)(z) = z + \sum_{m=2}^{\infty} a_m b_m z^m$.

The q-shifted factorial is defined for α, $q \in \mathbb{C}$ as a product of n factors by

$$(\alpha, q)_n = \begin{cases} 1, & n = 0 \\ (1-\alpha)(1-\alpha q)\cdots(1-\alpha q^{n-1}), & n \in \mathbb{N}, \end{cases} \tag{3}$$

1991 *Mathematics Subject Classification.* 30C45, 30C50.
Key words and phrases. Univalent functions, Bernardi operator, fractional derivative, q-derivative.
Submitted Feb. 25, 2018. Revised Nov. 22, 2018.

Int. J. Math. And Appl., 7(1)(2019), 155–160
ISSN: 2347-1557
Available Online: http://ijmaa.in/



International Journal of Mathematics And its Applications

On Generalized q-sakaguchi Type Functions

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Abstract: The aim of the present paper is to study new subclasses of functions defined by using generalized sakaguchi type functions and the concept of q derivative. The results investigated in this paper include coefficient inequalities, distortion inequalities, coefficient estimates etc.

MSC: 30C45.

Keywords: Analytic functions, q-calculus, Generalized Sakaguchi type function, Coefficient inequality.

1. Introduction

Let $\mathcal{A}$ denote the class of functions of the form

$$f(z) = z + \sum_{n=2}^{\infty} a_n z^n \tag{1}$$

which are analytic in the open unit disc $\mathcal{U} = \{z : z \in C \text{ and } |z| < 1\}$. Let $\mathcal{S}$ denote the familiar class of functions $f \in \mathcal{A}$ which are univalent in $\mathcal{U}$. A function $f(z) \in \mathcal{A}$ in (1) is said to be in the generalized sakaguchi class $\mathcal{S}(\alpha, s, t)$ defined by frasin [1] if it satisfies

$$\Re\left\{\frac{(s-t)zf'(z)}{f(sz)-f(tz)}\right\} > \alpha, \tag{2}$$

for some $\alpha(0 \leq \alpha < 1), |t| \leq 1, s \neq t$ and for all $z \in \mathcal{U}$. In 1910, Jackson [4, 5] presented a precise definition of q-difference operator and developed q-calculus in a systematic way.

$$\mathcal{D}_q f(z) = \frac{f(z) - f(qz)}{z(1-q)}, \quad (z \neq 0, 0 < q < 1), \quad (\mathcal{D}_q f(0) = f'(0)). \tag{3}$$

Equivalently (3), may be written as

$$\mathcal{D}_q f(z) = 1 + \sum_{n=2}^{\infty} [n]_q a_n z^{n-1} \quad z \neq 0,$$

where

$$[n]_q = \frac{1-q^n}{1-q}.$$

Note that as $q \to 1$, $[n]_q \to n$. Using the concept of q-derivative we introduce new subclasses of functions associated with generalized sakaguchi type functions as follows.

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CONVOLUTION CONDITIONS FOR SAKAGUCHI-JANOWSKI TYPE FUNCTIONS

SHILPA N[1], HAMID SHAMSAN[2], S. LATHA[3]

ABSTRACT. Convolution conditions for Sakaguchi-Janowski type functions are derived. Those results contains some interesting corollaries as special cases.

Keywords: Janowski functions, Sakaguchi functions, convolution.
2010 AMS Subject Classification: 30C45.

1. INTRODUCTION

Bieberbach conjecture, Milin conjecture, Robertson conjecture, Sheil-small conjecture, Rogosinsks conjecture, Littlewood conjecture...etc. attracted eminent mathematicians to work in theory of univalent functions. Attempts to prove or disprove these conjectures inspired research not only to develop elegant and useful techniques in complex analysis but also led to introduce and study of various subclasses of univalent functions. Functions with positive real part plays a crucial role in Geometric Function Theory as its significance can be seen from that all the simple subclasses of the class of univalent functions have been defined by using this concept. Motivated by this class Janowski [1] defined the class $P(A,B)$.

Let $\mathcal{A}$ denote the class of functions of form

$$f(z) = z + \sum_{n=2}^{\infty} a_n z^n, \tag{1.1}$$

which are analytic in the open unit disk

$$\mathcal{U} = \{z : z \in \mathbb{C} \text{ and } |z| < 1\},$$

and normalized by $f(0) = f'(0) - 1 = 0$. Let Ω denote the class of analytic functions ω in $\mathcal{U}$ with $\omega(0) = 0$, $|\omega(z)| < 1$. We denote by $P(A,B)$ the Janowski class containing functions p of the form

$$p(z) = \frac{1 + A\omega(z)}{1 + B\omega(z)}, \ -1 \leq B < A \leq 1, \ \omega \in \Omega.$$

South East Asian J. of Mathematics and Mathematical Sciences
Vol. 15, No. 3 (2019), pp. 41-52

ISSN (Online): 2582-0850

ISSN (Print): 0972-7752

SOME PROPERTIES OF SUBCLASSES OF ANALYTIC FUNCTIONS WITH NEGATIVE COEFFICIENTS

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(Received: *Aug. 13, 2019* **Accepted:** *Dec. 13, 2019* **Published:** *Dec. 31, 2019)*

Abstract: The object of the present paper is to define a new subclass $\mathcal{T}^{\zeta}_{m,\lambda}(A,B,\gamma)$ of analytic functions whose non-negative coefficients from the second onwards are negative by using the differential operator $D^{\zeta}_{m,\lambda}$. We derive some interesting properties like coefficient inequalities, distortion bounds, convolution conditions and a result which unifies radii of close-to-convexity, starlikeness and convexity.

Keywords and Phrases: Analytic functions, Modified Hadamard product, Coefficient inequalities, Convolution conditions, Al-Oboudi operator.

2010 Mathematics Subject Classification: 30C45.

1. Introduction

Let $\mathcal{A}$ be the class of analytic univalent functions f normalized by

$$f(z) = z + \sum_{k=2}^{\infty} a_k z^k, \tag{1.1}$$

which are analytic in the open unit disc $\mathcal{U}$.

Let $\mathcal{T}$ denote the subclass of analytic functions in $\mathcal{U}$, consisting of functions whose non-zero coefficients from the second onwards are negative, that is an analytic function $f \in \mathcal{T}$ if it has a Taylor expansion of the form

$$f(z) = z - \sum_{k=2}^{\infty} a_k z^k, \quad a_k \geq 0. \tag{1.2}$$

CORDIAL LABELING FOR THE LINE SPLITTING GRAPH OF SOME GRAPHS

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Abstract. In this paper we show that the line splitting graph of certain classes of graphs like path, cycle, fan, matching, $< C_n : P_n >$, quadrilateral snake are cordial.
2010 Mathematics Subject Classification: 05C78
Keywords and Phrases: Cordial labeling, line splitting graph

I. Introduction

All graphs in this paper are finite simple, undirected graph without loops or multiple edges. For graph theoretic terminology, we refer to [5].

A graph labeling is an assignment of integers to the vertices or edges or both, subject to certain conditions. During the past fifty years or so, an enormous amount of research work has been done on graph labeling and scores of graph labeling techniques have been developed and studied. For more details one may refer to the survey article [4] by J. A. Gallian. These interesting problems have been motivated by practical problems. Applications of graph labeling have been found in x-ray, crystallography, coding theory, radar, circuit design, astronomy and communication design. Particularly interesting applications of graph labelling can be found in Bloom and Golomb [1], [2].

Definition. A function $f: V(G) \longrightarrow \{0,1\}$ is called a binary vertex labeling of a graph G and $f(v)$ is called label of the vertex v of G under f. For an edge $e = uv$, the induced edge labeling $f^*: V(G) \longrightarrow \{0,1\}$ is given by $f^*(e) = |f(u) - f(v)|$.

The following notations are followed in this paper:
$v_f(0)$: number of vertices with label 0.
$v_f(1)$: number of vertices with label 1.
$e_f(0)$: number of edges with label 0.
$e_f(1)$: number of edges with label 1.

Definition. A binary vertex labeling of a graph G is called cordial labeling if $|v_f(0) - v_f(1)| \leq 1$ and $|e_f(0) - e_f(1)| \leq 1$. A graph G is cordial if it admits cordial labeling.

Cahit [3] introduced the concept of cordial labeling. This concept has been explored by many researchers and various labelling schemes are also introduced with minor variations in cordial theme. Product cordial labeling, total product cordial labelling and prime cordial labeling and divisor cordial labeling are to mention a few.

In [7] Lowrence Rozario Raj and Koilraj proved that the splitting graph of path, cycle, complete bipartite graph, matching graph, wheel, and $< K_{1,n}^{(1)} : K_{1,n}^{(2)} : \ldots : K_{1,n}^{(n)} >$ are cordial.

In this paper we prove that the line splitting graphbof certain classes graphs like path, cycle, fan, matching, $< C_n : P_n >$, quadrilateral snake are cordial.

The open neighborhood $N(u)$ of a vertex u in $V(G)$ is the set of vertices adjacent to u. For each vertex u_i of G, a new vertex u'_i is taken and the resulting set of vertices is denoted by $V_1(G)$.

The splitting graph $S(G)$ of a graph G is defined as the graph having vertex set $V(G) \cup V_1(G)$ with two vertices adjacent if they correspond to adjacent vertices of G or one corresponds to an element u'_i of $V_1(G)$ and the other to an element w_j of $V(G)$ where w_j is in $N(u_i)$ [9].

The open neighborhood $N(e_i)$ of an edge e_i in $E(G)$ is the set of edges adjacent to e_i. For each edge e_i of G, a new vertex e'_i is taken and the resulting set of vertices is denoted by $E_1(G)$.

The line splitting graph $L_S(G)$ of a graph G is defined as the graph having vertex set $E(G) \cup E_1(G)$ with two vertices adjacent if they correspond to adjacent edges of G or one corresponds to an element e'_i of $E_1(G)$ and the other to an element e_j of $E(G)$ where e_j is in $N(e_i)$ [6].

Let G and H be two graphs with $u \in V(G)$ and $v \in V(H)$. The amalgamation of (G,u) with (H,v) is the graph obtained by forming the disjoint union of G and H and then identifying u and v. We will use amal $(G, H(u,v))$ to denote the amalgamation of (G,u) with (H,v).

Graph $G =< C_n : P_n >$ is the graph obtained by identifying one end vertex of P_n with a vertex of C_n.

The Quadrilateral snake Q_n is obtained from a Path $P = \{v_1, v_2, \ldots, v_n\}$ by joining v_i and v_{i+1} to new vertices u_i and w_i, respectively and then joining u_i and w_i. That is every edge of Path is replaced by a Cycle C_4.

II. Main Results

Theorem. The graph $L_S(P_n)$ is cordial.

Proof. Let $G = P_n$. Let $V(G) = \{v_1, v_2, \ldots, v_n\}$ and $E(G) = \{e_1, e_2, \ldots, e_{n-1}\}$. Then $L_S(G)$ has vertices $e_1, e_2, \ldots, e_{n-1}, e'_1, e'_2, \ldots, e'_{n-1}$. The vertex labeling $f: V(L_S(G)) \longrightarrow \{0,1\}$ is given below

Zinc oxide nanoparticles: A significant review on synthetic strategies, characterization and applications

Cite as: AIP Conference Proceedings **2162**, 020089 (2019); https://doi.org/10.1063/1.5130299
Published Online: 29 October 2019

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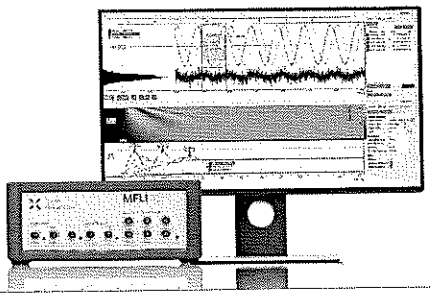

Journal of Materials Science: Materials in Electronics (2020) 31:1004–1021
https://doi.org/10.1007/s10854-019-02612-2

Facile microwave-assisted green synthesis of ZnO nanoparticles: application to photodegradation, antibacterial and antioxidant

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Received: 3 June 2019 / Accepted: 18 November 2019 / Published online: 26 November 2019

Abstract
The present study reports the effective synthesis of zinc oxide nanoparticles (ZnO Nps) by microwave irradiation method using Indian bael (*Aegle marmelos*) juice as fuel. The synthesized nanostructures were characterized by X-ray diffraction, FT-IR, scanning electron microscope, transmission electron microscope, Raman Spectroscopy, photoluminescence and ultraviolet (UV)–visible studies. At room temperature, photoluminescence spectrum showed the excitation wavelength at 370 nm and emission peaks at 388 and 468 nm corresponding to Zn vacancies and O vacancies, respectively. Further, the effectiveness of the synthesized zinc oxide nanoparticles was tested for methylene blue dye degradation under UV irradiation. The dye removal efficiency of nanoparticles was 96% after 35 min of UV ($\lambda = 617$ nm) irradiation. The ZnO nanoparticles were subjected to antimicrobial activity against different strains. The current synthetic work pledges to provide some new visions into the design of nanomaterial for multifunctional long-term applications for cleanup and biomedical applications.

1 Introduction

Recently, with rapid industrialization, globalization and urbanization, the water pollution is caused by the industrial wastes, especially organic compounds like methylene blue, indigo carmine, methyl orange, etc., are used to impart colour to the fabrics and papers by forming physical and chemical bonding, and these compounds become a major problem in the world. Pure water is essential for survival of humans, animals and ecosystem. Several methods like permeable membrane separation, adsorption and coagulation are available, but these methods are insufficient as some organic dyes are difficult to degrade, whereas some are not readily adsorbed and escape the treatment process. Because of these reasons, the degradation of organic dyes by means of photocatalysts has been widely utilized as an effective approach to remove organic pollutants in waste water and sewages. Since, Fujishima and Honda published the photocatalysis of water [1], varieties of semiconductor metal oxides, such as, ZnS [2], ZnO [3, 4], TiO_2 [5–7], ZrO_2 [8], CuO [9], CdS [10, 11], NiO [12] Cu_2O [13, 14], Ta_2O_5 [15], $FeVO_4$ [16], $ZnTiO_3$ [17], $CuInS_2$ [18], $ZnFe_2O_4$ [19] and CdSe [20], have been synthesized to decompose environmental contaminants. Among those semiconductors, ZnO has been considered as a favourable contender owing to its non-hazardous and economical characteristics like high thermal, chemical immovability, resistivity control, piezoelectric properties, high quantum field, flexible morphologies, superior electrical and optical properties [21, 22]. Further, ZnO Nps have been measured to have potential biological applications as proficient antibacterial, and antifungal agents, bio-imaging probes, drug carriers and possessing cytotoxic activities for the cure of cancer [23–29]. In addition, ZnO has been considered as a phosphorescence exhibiting material for display devices because it shows strong green emission after thermal treatment in a reducing atmosphere [14–18]. The efficacy of photocurrent conversion of the untouched ZnO is still

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